Research Report 1312

II (12)

EMPLACING, FIRING, AND MARCH ORDERING AN M109A1 HOWITZER: TASKS AND TASK TIMES

Jay S. Coke, Lloyd M. Crumley, and
Robert C. Schwalm

ARI FIELD UNIT AT FORT SILL, OKLAHOMA

U. S. Army
Research Institute for the Behavioral and Social Sciences

June 1981

Approved for public release; distribution unlimited.

U. S. ARMY RESEARCH INSTITUTE
FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency under the Jurisdiction of the

Deputy Chief of Staff for Personnel

JOSEPH ZEIDNER
Technical Director

L. NEALE COSBY
Colonel, IN
Commander

NOTICES

<u>DISTRIBUTION</u>: Primary distribution of this report has been made by ARI. Please address correspondence concerning distribution of reports to: U.S. Army Research Institute for the Behavioral and Social Sciences, ATTN: PERI-TST, 5001 Eisenhower Avenue, Alexandria, Virginia 22333.

<u>FINAL DISPOSITION</u>: This report may be destroyed when it is no longer needed. Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

<u>NOTE</u>: The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Research Report 1312	2. GOVT ACCESSION NO. AD-A109 706	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) EMPLACING, FIRING, AND MARCH ORDERING AN M109A1 HOWITZER: TASKS AND TASK TIMES		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER --
7. AUTHOR(s) Jay S. Coke Lloyd M. Crumley Robert C. Schwalm		8. CONTRACT OR GRANT NUMBER(s) --
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue, Alexandria, VA 22333		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q262717A790
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Field Artillery School Fort Sill, OK 73503		12. REPORT DATE June 1981
		13. NUMBER OF PAGES 38
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) --		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE --

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

--

18. SUPPLEMENTARY NOTES

--

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Computer simulation
Task library
Crew-served weapon systems
Crew performance

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

If there is ever a conflict in Europe between NATO forces and current threat forces, crews operating weapon systems might be forced to fight around the clock for up to 8 consecutive days. To assess the effects of prolonged continuous operations on crew performance, the Fort Sill Field Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences has developed a computer-based simulation model. One major component of this model

(Continued)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Item 20 (Continued)

is a task library. The task library, which will differ depending upon the weapon system being simulated, contains a definition of each task required to operate a weapon and numerical values for relevant task parameters, including the minimum, average, and maximum time required to perform the task. This report describes the development of a task library for the M109A1 155mm self-propelled howitzer, the weapon system chosen as the test bed for the research effort on continuous operations.

Research Report 1312

EMPLACING, FIRING, AND MARCH ORDERING AN M109A1 HOWITZER: TASKS AND TASK TIMES

Jay S. Coke, Lloyd M. Crumley, and
Robert C. Schwalm

Submitted by:
James A. Bynum, Chief
ARI FIELD UNIT AT FORT SILL, OKLAHOMA

Approved by:

E. Ralph Dusek, Director
PERSONNEL AND TRAINING
RESEARCH LABORATORY

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES
5001 Eisenhower Avenue, Alexandria, Virginia 22333

Office, Deputy Chief of Staff for Personnel
Department of the Army

June 1981

Army Project Number
2Q262717A790

Human Performance
Effectiveness and Simulation

ARI Research Reports and Technical Reports are intended for sponsors of R&D tasks and for other research and military agencies. Any findings ready for implementation at the time of publication are presented in the last part of the Brief. Upon completion of a major phase of the task, formal recommendations for official action normally are conveyed to appropriate military agencies by briefing or Disposition Form.

FOREWORD

The Fort Sill Field Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) is conducting research to determine the effects of continuous operations on the performance of crews as they operate weapon systems. In conducting this research, the Field Unit has developed a computer-based model that will simulate the effects on performance of crew size, task assignment structure, and fatigue and lack of adequate sleep. To simulate the performance of a crew on a particular weapon system, one must have a task library for that system; this library must contain the tasks that are performed in operating the system and the minimum, average, and maximum time required to perform them.

This report describes the development of a task library for the M109A1 155mm self-propelled howitzer, the weapon system chosen as the test bed for the research effort on continuous operations. The research reported was conducted under RDT&E Project 2Q263743A794, FY 1980 Work Program, in response to requirements of the U.S. Army Field Artillery School, Fort Sill, Okla.

JOSEPH ZEIDNER
Technical Director

EMPLACING, FIRING, AND MARCH ORDERING AN M109A1 HOWITZER: TASKS AND TASK TIMES

BRIEF

Requirement:

It is expected that if there is ever a conflict between NATO and Warsaw Pact forces in Europe, howitzer sections, and other crew-served weapons, will be forced to fight around the clock for up to 8 consecutive days. To begin to assess the effects of prolonged continuous operations on the performance of such crews, the Fort Sill Field Unit of the Army Research Institute has developed a computer-based simulation model. The model uses the M109A1, 155mm howitzer as a test bed. One component of this model is a library that contains a definition of each task required to operate a howitzer and numerical values for relevant task parameters, including the minimum, average, and maximum time required to perform the task. The purpose of the research described in this report was to gather the task and task time data necessary to build a library for evaluation of M109A1 howitzer crews.

Procedure:

To determine the minimum, average, and maximum times to perform each task, three methods were used. The first method consisted of videotaping howitzer crews in action and then using the tapes to measure how long it took to perform individual tasks. Since it was impossible to determine from the videotapes the times for all the listed tasks, two back-up time estimation methods were used. The first of these back-up methods consisted of timing one well-trained individual as he performed a task. The second consisted of having a subject matter expert estimate the time it would take to perform a task.

Findings:

By using the procedure outlined above it was possible to determine the minimum, average, and maximum times required for members of a howitzer crew to perform their tasks.

Utilization of Findings:

1. The task library developed provides an adequate data base for initial studies of the effects of crew size and task structure.

2. The task library can be upgraded to provide additional outputs concerning "typical" crews if desired.

3. The present task library is adequate for further development of the model to predict decrements resulting from fatigue or lack of adequate sleep or other parameters that affect speed of performance.

4. The results of the research suggest that it would be feasible to develop task libraries for weapon systems other than the M109A1 howitzer. The computer-based model could then be used to simulate the performance of crews operating those systems.

EMPLACING, FIRING, AND MARCH ORDERING AN M109A1 HOWITZER: TASKS AND TASK TIMES

CONTENTS

LIST OF TABLES

LIST OF FIGURES

EMPLACING, FIRING, AND MARCH ORDERING AN M109A1 HOWITZER: TASKS AND TASK TIMES

INTRODUCTION

Decision makers in the U.S. Army Field Artillery are concerned about the performance of howitzer sections during the kind of battles envisioned if there is ever a conflict in the European theater with current threat forces. It is assumed that a European conflict would be short, lasting perhaps only a week or two. It is also assumed, though, that it would be intense. Because technological advances have greatly increased the capacity for night operations, battles can now be fought around the clock. Thus, howitzer sections might be forced to fight continuously for several consecutive days.

This continuous operations scenario suggests the need to assess the effects of certain variables on the performance of howitzer crews. Obvious variables are fatigue and lack of sleep. Less obvious but equally important variables are crew size and allocation of tasks among crew members. Since continuous operations will force crew members to fight and rest in shifts, and since crew members, besides fighting and resting, must perform certain off-howitzer support tasks, the full crew will never be available to operate the howitzer. How many men, then, are needed to operate the howitzer and complete all support duties at acceptable levels of performance? How can one best assign tasks so as to minimize the effects of having a limited number of crew members?

Effects of Fatigue and Inadequate Sleep

The effects of fatigue and lack of adequate sleep on performance are easy to visualize. As crew members grow physically fatigued, they move more slowly while performing the individual tasks involved in emplacing, firing, or march ordering a howitzer. Inadequate sleep, even when it does not involve physical fatigue, causes lapses of attention, slower performance of cognitive operations, and reduced eye-hand coordination. Thus, fatigue and lack of adequate sleep will cause many individual tasks to be performed more slowly. When individual tasks in a task sequence are performed more slowly, the sequence as a whole will, of course, be performed more slowly.[1]

---

[1] It is assumed in this paper that speed is a critical measure of crew performance. Another measure that might be considered critical is error rate. With howitzer crews, though, errors are usually reflected in speed: When a crew member makes an error in performing a task, he corrects the error and correcting the error takes time.

Effects of Crew Size and Task Structure

The effects of crew size and task structure are more difficult to visualize than the effects of fatigue and inadequate sleep. Crew size and task structure do not affect the speed of performance of individual tasks. Instead, they affect the speed of performance of sequences of tasks by affecting the scheduling of individual tasks.

A conceptual analysis of the effects of crew size and task structure on crew performance suggests two useful indicators of performance effectiveness. The first indicator is obvious and has already been suggested: speed of performance, where speed is inversely related to time required to perform an activity such as emplacing, firing, or march ordering the howitzer (increased speed = decreased time). The second indicator is less obvious: idle time, the amount of time individual crew members are not working during the performance of an activity.

Tasks involved in an activity such as firing the howitzer are performed either simultaneously or sequentially, and they are performed sequentially for reasons either intrinsic or extrinsic to the tasks. To illustrate, in firing a howitzer the projectile <u>must</u> be fuzed before it can be fired. This sequencing is intrinsic to the tasks. Fuzing the projectile and preparing the propellant charge, though, could be done either sequentially or simultaneously. Obviously, the activity of firing the howitzer will be completed more rapidly if these tasks are performed simultaneously. Perhaps, however, there is only one man available to do both tasks; the tasks will then be performed sequentially but for reasons extrinsic to the tasks. When tasks are performed sequentially, for intrinsic or extrinsic reasons, one seeks to minimize occasions where one man ready to begin a task is forced to be idle while waiting for another man to complete a prior task within the sequence.

Given a specified series of tasks and a specified crew size, the task assignment structure that minimizes idle time should also minimize the total time to perform the tasks. The amount of work to be done is determined by the tasks and the environment in which the tasks are to be performed; total time to perform an activity can be shortened only through the effect of task structure on idle time (Total Time = Work Time/Crew Size + Idle Time/Crew Size). Thus, with movement toward the optimal task structure, both performance indicators move in the desired direction.

Changes in crew size will move only one of the two indicators in the desired direction. Increasing crew size will increase speed of performance to the extent that it allows the simultaneous performance of tasks that had been performed sequentially with smaller crews. Increasing crew size, however, will increase idle time. Conversely, decreasing crew size will decrease speed of performance to the extent that it forces the sequential performance of tasks that could be performed simultaneously. Decreasing crew size, however, will also decrease idle time. In making decisions about crew size, then, one must be concerned with trade-offs between speed of performance and efficient use of available manpower.

Simulation Model

The U.S. Army Research Institute, Fort Sill Field Unit, is currently developing methods and collecting data that will allow decision makers to assess the effects of the variables discussed above without having to perform the costly operation of observing crews of different sizes, with different task assignments, operating at different levels of fatigue. An important part of this process is the development of a computer model that simulates the performance of howitzer crews.[2]

This model consists of three segments. One segment is the computer program that simulates the performance of howitzer crews. The second is a task library that contains a definition of each task required to operate a howitzer and numerical values for relevant task parameters. The parameters include the minimum, average, and maximum time required to perform the task. The third segment specifies the size of the crew being simulated and the allocation of tasks among crew members. This segment also specifies the number of iterations the simulation program is to complete.

Given appropriate inputs (i.e., the second and third segments), the simulation program provides information about the speed with which the crew being simulated would perform such activities as emplacing, firing, or march ordering the howitzer. Suppose, for example, that one simulates emplacement and asks for 200 iterations. The simulation program will determine the time required to emplace the howitzer by calculating the time required to complete each individual task involved in this activity and by taking into account the scheduling of the tasks. The 200 times for emplacement calculated by the model will differ from one another because the model is probabilistic. Assume, for example, that the minimum time to complete a particular task is 1 second, the average is 2 seconds, and the maximum is 5 seconds. For any one iteration of the emplacement activity, the simulation model would randomly select a time somewhere between 1 and 5 seconds for that task. Since times for the individual tasks vary from iteration to iteration, the total times for the activity will, of course, also vary.

The program provides summary information on the iterations performed. Presented are the minimum time to perform the activity, the times at the 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, and 90th percentiles of the distribution, and the maximum time to perform the activity. The simulation program also provides a count of how often each man was the "critical" man (i.e., the number of iterations during which he worked the greatest amount of time) and the average amount of time each man was idle. Thus, the model provides output on speed of performance and idle time, the two indicators of performance effectiveness discussed earlier. To summarize, the simulation model operates as follows:

1. Tasks are defined and placed in the task library with each task entry consisting of the items described in Table 1.

---

[2]For a complete description of the model, see Schwalm, R. C., Crumley, L. M., Coke, J. S., & Sachs, S. A. A Description of the ARI Crew Performance Model. ARI Research Report, in press.

2. Information about crew size and task assignment is input through a set of control cards. Also included in the control cards is the number of iterations the simulation model is to complete.

3. Based upon the information given, the simulation program will make its calculations and print out the summary information described above.

Table 1

Task Library Data Entries and Column Locations on 80-Column Card Image

Column	Data entry
2-5	Task number
7-10	Hold (number of another task that must be performed before this task can be performed)
12-15	Concurrent (number of another task that must be performed concurrently with this task)
16-20	Minimum time in seconds to perform the task
21-25	Average time in seconds to perform the task
26-30	Maximum time in seconds to perform the task
40	Source of the time data

PURPOSE

The purpose of the research described in this report was to develop a library of the tasks performed by M109A1 howitzer crews. The task library makes it possible to simulate the performance of howitzer crews of different sizes and with different task assignment structures. The task library also provides a data base for later simulations of the effects of fatigue and inadequate sleep on performance. Before such simulations can be run, however, more information about the effects of fatigue and inadequate sleep on performance is needed. Research to acquire that information is planned.

APPROACH

The M109A1 howitzer section, which consists of a 155mm self-propelled howitzer, an M548 section vehicle, and a nominal 10-man crew, was selected as the test bed for the modeling effort. Development of the task library

involved two major efforts: developing a comprehensive list of tasks required to operate a howitzer, and obtaining data that describe the range of times required to perform the various tasks.

Development of a Task List

The tasks making up an initial task list were gathered from the following documents: (1) FM 6-88 (155mm Howitzer M109, M109A1, Self-Propelled); (2) TM 9-2350-217-10N (Operation and Maintenance Manual (User) for Howitzer, Medium, Self-Propelled: 155mm M109 (2350-00-440-8811) and 155mm M109A1 (2350-00-485-9662)); and (3) WCXXMG, HO (Duties of the Personnel of the 155mm Howitzer M109/M109A1 Self-Propelled Section). This task list is shown in Appendix A. Some tasks in the initial list were then broken into smaller task units. This was done if it appeared possible that the different units might profitably be performed by two or more men instead of one or if it appeared possible that there might sometimes be a gap in time between the performance of one unit and the performance of another. Also a series of locomotion tasks was added so that the crew simulations could reflect the requirement that crew members move to and from various work locations. In all, approximately 200 tasks were identified. The tasks that make up the final task library are shown in Appendix B.

After the task list was developed, a further analysis was performed to identify constraints intrinsic to the tasks that force some tasks to be performed sequentially and some to be performed concurrently. For example, in firing the howitzer, the gunner cannot properly perform Task 100, "Sets deflection," until the chief of section performs Task 12, "Announces deflection." The entry for Task 100 reflects this constraint: In columns 7-10, Task 12 appears indicating that Task 100 cannot be performed until Task 12 has been completed (see the fire mission tasks in Appendix B). This means that Task 100 must "hold" for Task 12. When calculating the time required to fire the howitzer, the simulation program takes account of this constraint.[3]

Task 500, "Holds projectile while another affixes and sets fuze," must be performed concurrently with Task 404, "Affixes and sets fuze." The library entry for Task 500 reflects this constraint: In columns 12-15, Task 404 appears indicating that Task 500 must be performed concurrently with Task 404 (again see the fire mission tasks in Appendix B).

---

[3]The gunner could of course set a deflection before the chief of section announced the one sent by the fire direction center. A howitzer crew that followed this procedure, however, would seldom place its projectiles in the desired location. We identified those tasks that must be performed sequentially or concurrently if the weapon system is to operate as intended (i.e., intrinsic constraints). Identification of constraints requires knowledge of the system.

Task Time Data Collection

To estimate the minimum, average, and maximum times to perform the tasks, three methods were used. The first method consisted of videotaping howitzer crews in action and then using the tapes to measure how long it took to perform individual tasks. Since it was impossible to determine from the videotapes the times for all the listed tasks, two back-up time estimation methods were used. The first back-up method consisted of timing one well-trained individual as he performed a task. The second consisted of having a subject matter expert estimate the time it would take to perform a task.

Videotaping. The major method of data collection consisted of filming two howitzer crews. The crews and equipment came from III Corps Artillery, 75th FA Group, 2nd Battalion, 34th FA. Each crew used one M109A1 155mm self-propelled howitzer, one M548 section vehicle, and all the equipment associated with these two vehicles. The M548 was loaded with 10 pallets of high explosive (HE) projectiles and 36 powder cannisters. Each pallet contained 8 projectiles and each cannister contained 2 green bag propellant charges.

The two crews were videotaped on separate days. The weather on both days was good and should not have adversely affected performance. Each crew repeated four times the sequence of emplacing the howitzer, firing three rounds, and then march ordering the howitzer. Support elements required to perform these activities were furnished. Laying the howitzer for direction required an aiming circle, a man to operate the aiming circle, and a communications wire between the aiming circle and the howitzer. Firing the howitzer required a fire direction center (FDC) to transmit fire missions to the howitzer crew and a forward observer (FO) to observe the fired rounds in the target area.

Because the data were intended to be applicable to combat operations, the crews were instructed to operate as they would in combat. The crews were also directed to work out of the back of the ammunition carrier in preparing ammunition for firing. In training exercises, crews usually unload their ammunition and prepare it for firing on the ground beside the howitzer. This procedure is easier than working out of the back of an ammunition carrier. In combat, however, a crew might be forced by enemy action to march order rapidly and the crew would not have time to reload ammunition into the carrier. Thus, in combat, a crew would be forced to work out of the ammunition carrier.

The fire missions transmitted to the howitzer crews were also designed to be representative of combat. Since target locations vary from fire mission to fire mission, the crew must frequently change the deflection and quadrant settings on the fire control instruments of the howitzer. Further, howitzer crews are called upon to fire various kinds of projectiles and fuzes, the shell-fuze combination fired depending upon characteristics of the target.

These variations were reflected in the fire mission. There were five elements in each fire mission transmitted to the howitzer crews: projectile

location, charge, fuze, deflection, and quadrant. One element was constant: The crews always fired charge 5. Each of the other four elements varied from round to round. Although all projectiles fired by the howitzer crews were HE, the FDC directed the howitzer crews to get their projectiles from a pallet either at the front, middle, or rear of the M548. This requirement simulated a combat situation in which a crew might have to obtain different kinds of projectiles from different locations within the ammunition carrier. The FDC also directed the howitzer crews to fire either point detonating (PD), variable time (VT), or time (Ti) fuzes. Deflection and quadrant were varied from one round to the next within the constraint that the fired round had to land in a specified target area.

As the howitzer crews worked, they were filmed by three camera operators who carried portable videotape cameras and recording units. Each camera was equipped with a directional microphone. To facilitate filming, the howitzer and ammunition carrier were emplaced in an open field in the configuration shown in Figure 1. In combat, of course, a howitzer battery would seek a concealed position.

Figure 1 also shows the positions to which each of the three camera operators moved as the howitzer and ammunition carrier drove into position. As can be seen in Figure 1, one camera looked directly into the back of the howitzer, one looked into the back of the ammunition carrier, and one focused on the left side of the howitzer, a location where considerable activity takes place during emplacements and march orders.

When the filming was completed, a running digital clock accurate to the half-second was superimposed in the lower right-hand corner of the videotape. Two researchers then recorded the start and stop points of tasks to the nearest second. They subsequently used this information to calculate the total task time in seconds. For some tasks, the start or stop point was based on oral commands or statements. Usually, though, the start and stop points were based on visual information.

During the initial phases of data reduction, the two researchers independently observed the same tapes. When large discrepancies in times recorded for a task occurred, it was because the two researchers interpreted the actions of a crew member differently. The researchers resolved such discrepancies by reviewing the tape, discussing their two interpretations in light of the review, and deciding which interpretation was correct. In nearly all cases, however, the times the researchers recorded for a task were within one second of being in agreement. Because the times were so close, no formal assessment of reliability was considered necessary.

Individual Task Timing and Time Estimate. Since it was impossible to videotape all the tasks listed in the task list, some data were collected by alternative methods. Indeed, despite the instructions to the howitzer crews to operate as if in combat, they failed to perform some tasks that should have been performed. To generate estimates of the time to perform the tasks not performed or not visible, two back-up methods were used. One method involved timing an individual as he performed the tasks; the other involved estimating the times. Generally, the times for the simple tasks that had not been filmed were obtained by timing a USAFACFS Weapons Department instructor performing the tasks. For more

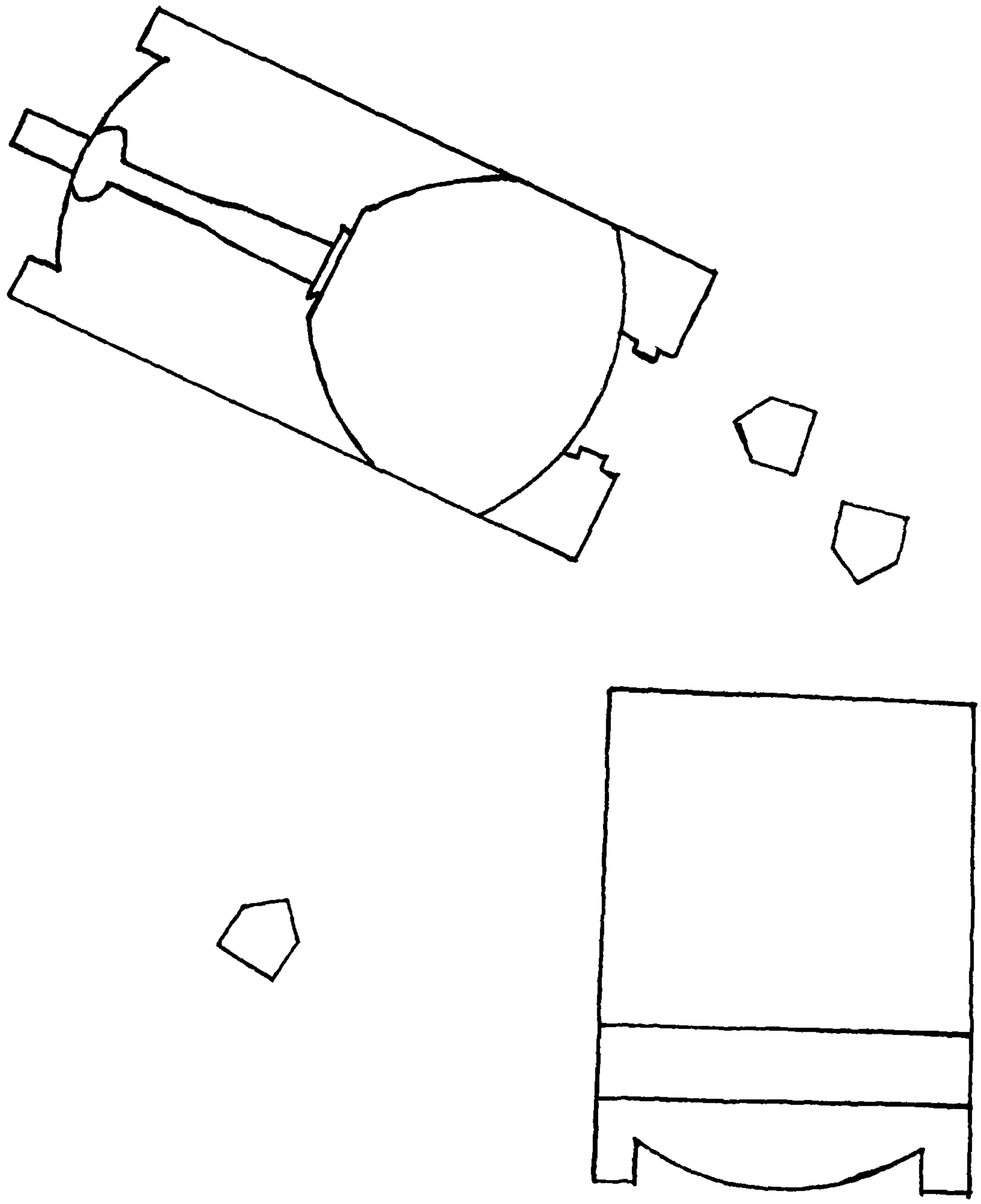

Figure 1. Relative positions of M109A1 howitzer, M548 ammunition carrier, and the three camera operators.

complex tasks where it seemed likely that the time to perform a task would vary widely depending on the performer's skill level, the instructor provided minimum, average, and maximum time estimates for a "typical" crewman.

RESULTS

The completed task library is shown in Appendix B. Two lines are used to describe each task, the first line consisting of numerical values for the task parameters and the second line consisting of a brief verbal description of the task. The data entries appearing on the first line have been described briefly in Table 1.

The entries for hold, concurrent, and source of time data, however, need some explanation beyond that provided in the table. The hold and concurrent entries are used to reflect constraints intrinsic to the tasks. If the task being described cannot be performed until another task has been performed, the number of that other task appears in the hold columns. If the task being described must be performed concurrently with another task, the number of that other task appears in the concurrent columns.

As is indicated in Table 1, the entry in column 40 indicates the source of the time data for the task. If the time data for a task were based on observation of the howitzer crews, a "1" appears in column 40.[4] If times for a task could not be directly determined from observation of the videotapes but could be inferred from the tapes, a "2" appears in column 40. If the data were obtained by timing the USAFACFS instructor, a "3" appears. If the data were the estimates of a subject matter expert, a "4" appears.[5] Of the times for the 161 nonlocomotion tasks, 66 were obtained by observation of the videotapes, 7 were inferred from the videotapes, 21 were obtained by timing the performance of the USAFACFS instructor, and 67 were estimates of the USAFACFS instructor.

An attempt was made to organize the task library in such a way that it would be easy to use. The task library was divided into three segments representing the three major activities engaged in by a howitzer crew: emplacing, firing, and march ordering. The numbers assigned to the tasks indicate which crew member usually performs the tasks. Tasks were assigned numbers according to the following scheme: 0-99, Chief of Section; 100-199, gunner; 200-299, assistant gunner; 300-399, number 1 cannoneer; 400-499,

---

[4]Even for tasks assigned a "1" in column 40, subjective judgment was sometimes involved in determining the minimum, average, and maximum times. If we thought that a time recorded for a task was for some reason atypical, the time was disregarded. On one occasion, for example, a howitzer crew member made several mistakes in fuzing a projectile. Using his time on that occasion as the maximum time would have greatly distorted the distribution for the task.

[5]It was assumed that times for tasks would generally be positively skewed. If an error is made in performing a task, the time required to perform the task might be considerably increased. There is no corresponding mechanism that might decrease the time required to perform a task.

number 2 cannoneer; 500-599, number 3 cannoneer; 600-699, number 4 cannoneer; 700-799, number 5 cannoneer; 800-899, motor driver; and 900-999, section driver.

For convenience of presentation, the locomotion tasks were shown as a separate segment in Appendix B. To actually use the model to simulate an activity, however, the locomotion tasks would have to be entered in the same segment or file as the tasks for that activity. Thus, the same locomotion tasks would be entered in the file with the emplacement tasks, the file with the fire mission tasks, and the file with the march order tasks.

DISCUSSION

The purpose of the present research was to collect data that could be useful in evaluating the effects on performance of different crew sizes and different task assignments within a given crew size. For this specific purpose, a sample of two howitzer crews was sufficient. Lest the reader make inferences not justified by the data, however, a caveat is in order. One might be tempted to assume that the performance of most howitzer crews would be similar to the performance of the crews studied and that one could, therefore, predict the level of performance of howitzer crews in general from the data collected. Given the small sample of crews, this assumption is unwarranted. The performance of howitzer crews must fall along a distribution, some crews being fast, some slow, some average. With our sample of only two crews, one should not assume that they were average or typical.

It would be desirable in the future to collect data from a much larger sample of howitzer crews. This would increase the power of the simulation model since one could use it to predict the performance of howitzer batteries in particular battle scenarios. How many sections, for example, would be able to fire the number of rounds per day and make the number of moves per day envisioned in the European scenario?

Still, the small sample used in the present research does not lessen the value of the data in accomplishing the purpose for which they were intended. Even if the two crews studied were far faster or far slower than the average howitzer crew, the data could still be used to evaluate the effects of different crew sizes and task assignment structures. Consider, for example, two 10-man crews, one of which can perform twice as fast as the other all the tasks involved in emplacing a howitzer. The time it takes to emplace the howitzer with the full crew provides a base line measure of performance for each crew. If we took several men from each crew and distributed the tasks these men had performed among the remaining crew members, the speed of both crews would probably decrease by some amount and not necessarily the same amount. The key point, though, is that losing the men would cause approximately the same percentage decrease in speed relative to the base line for both the fast and the slow crew. Hence the fast and the slow crew data would lead one to draw the same inference about the effects of crew size changes.

Another issue of concern is the relatively large number of tasks with time data based on the back-up methods of data collection. It certainly

would have been preferable to determine the times for each task by observing howitzer crews. As with the small sample of crews, however, the use of back-up methods of data collection does not lessen the value of the data for making inferences about the effects of different crew sizes or task structures. It is unlikely that any errors in the times based on the back-up methods are sufficiently large that they would lead to incorrect inferences about the effects of these variables. Further, as decision makers move toward any final decisions about crew size or task structure, the task library will be updated with more accurate times if that becomes necessary.

CONCLUSIONS

1. The present task library provides an adequate data base for initial studies of the effects of crew size and task structure using the simulation model.

2. The task library can be upgraded to provide additional outputs concerning "typical" crews if desired.

3. The present task library is adequate for further development of the model to predict decrements resulting from fatigue or lack of adequate sleep or other parameters that affect speed of performance.

4. The present results suggest that it would be feasible to develop task libraries for weapon systems other than the M109A1 howitzer. The computer-based model could then be used to simulate the performance of crews operating those systems.

APPENDIX A

TABLE 1

LIST OF TASKS PERFORMED BY CREW DURING THE PROCESS OF LAYING A HOWITZER

CHIEF OF SECTION

1. Gives command to prepare for action.

2. Supervises work of cannoneers during all activities.

3. Directs backing of carriage against spades. Directs driver to cut engine and set brakes.

4. Checks position of replenisher indicator and recuperator guide pins. Checks recoil system for leaks. Directs servicing as required.

5. Verifies the adjustment of the sighting and fire control equipment to insure that the howitzer has been properly laid.

6. Assisted by the gunner, measures angle of site to crest.

7. Indicates alternative aiming point to the gunner.

8. Supervises gunner and assistant gunner as they boresight or check previous boresighting.

9. Reports to executive officer that the howitzer is prepared for action or reports any defects that the section cannot remedy without delay.

GUNNER

1. Depresses left pedal latch when spades are used. Opens left cab door.

2. Removes collimator and hands it to number 4.

3. Releases cab traverse lock. Places cab power switch in the on position and places the elevation switch in the gunner position for power elevation.

4. Assists driver in disengaging howitzer travel lock, and then depresses tube to minimum elevation so number 5 can remove the muzzle cover and plug. Places the elevation control switch in the number 1 man position for power elevation. Checks power and manual traverse.

5. Commands the driver to lift and lock ballistic cover, and installs panoramic telescope. Uncovers azimuth counter. Zeroes the gunner's aid counter and levels the telescope mount.

6. Lays the howitzer for direction. Directs alinement of collimator and resets counter to 3,200 mils. Directs alinement of aiming posts so that an alternative to the collimator is available. Identifies and records deflection to alternative aiming point.

7. Assists chief of section in measuring angle of site to crest.

8. Boresights the weapon or checks previous broesighting.

ASSISTANT GUNNER

1. Depresses right pedal latch. Opens right cab door.

2. Checks functioning of elevating mechanism, power and manual.

3. Elevates the tube to loading elevation. Centers cross-level bubbles. Sets correction counter to zero.

4. Checks direct fire telescope.

5. Assists chief of section in measuring site to crest.

6. Boresights direct fire telescope.

NUMBER 1 CANNONEER

1. Opens rear cab doors and dismounts.

2. Removes left spade strut safety pin. Releases left locking latch and lowers spade to ground.

3. Procures lanyard; operates firing mechanism; inspects, operates, and cleans the breechblock, power rammer, chamber, bore, primer seat, and obturator vent; leaves the breechblock open.

4. Procures sponge, burlap, and bucket of water and places them in a convenient location.

5. Procures primers and places them in a convenient and safe location.

NUMBER 2 CANNONEER

1. Opens and holds rear hull door while the chief of section and numbers 1 and 2 dismount; then closes hull door for emplacement of the spades.

2. Removes right spade strut safety pin. Removes right locking latch and lowers spade to ground.

3. Procures fuze setters and, assisted by number 3, unloads fuze boxes and opens boxes and arranges fuzes as directed by the chief of section.

NUMBER 3 CANNONEER

1. Assists number 2 in unloading and opening fuze boxes and arranging fuzes.

2. Does other tasks as directed by the chief of section.

NUMBER 4 CANNONEER

1. Obtains collimator from gunner and places it to the left front of the howitzer. Alines the collimator in accordance with directions from the gunner.

2. Assembles aiming posts and places them to the right rear of the piece for number 5.

3. Assembles rammer staffs.

4. Does other tasks as directed by chief of section.

NUMBER 5 CANNONEER

1. Acts as gun guide when required. Guides piece into position parallel with stakes.

2. Plugs the piece into the battery communication system.

3. Removes muzzle cover and plug, folds the cover, and places the cover and plug in the driver's compartment.

4. Alines aiming posts in accordance with directions from the gunner.

5. Emplaces muzzle boresight when required.

6. Does other tasks as directed by the chief of section.

MOTOR CARRIAGE DRIVER

1. When directed by chief of section, backs carriage against the spades. Sets brakes and stops the engine.

2. Assisted by the gunner, disengages and secures the howitzer travel lock.

3. Opens and locks direct fire telescope window. Lifts and locks the ballistic cover on command of the gunner.

4. Puts instrument panel inside driver's compartment and closes and secures hatch.

5. Does other tasks as directed by the chief of section.

SECTION VEHICLE DRIVER

1. Does tasks as directed by the chief of section.

TABLE 2

LIST OF TASKS PERFORMED BY CREW DURING FIRE MISSION

CHIEF OF SECTION

1. Commands the section during firing and insures an efficient and safe operation.

2. Follows fire commands and repeats commands to section as required to insure efficiency and safety.

3. Verifies the adjustment of the sighting and fire control equipment.

4. Checks all ammunition components of a complete round that has been prepared for firing before it is loaded in the cannon tube.

5. Indicates that the howitzer is ready to fire by extending his right arm vertically and reporting to the fire direction center.

6. Drops his right arm sharply to his side and gives the command to fire.

GUNNER

1. Sets announced deflection on the reset counter by turning the azimuth knob.

2. Traverses the tube until the vertical reticle of the telescope is correctly alined with the collimator or until it is on the left edge of the aiming point.

3. Centers the pitch- and cross-level bubbles.

4. Calls "ready" after the piece is laid for direction and the assistant gunner has called "set".

ASSISTANT GUNNER

1. Using the elevation knob, sets the announced quadrant on the elevation counter.

2. Elevates the tube until the elevation level bubble is centered.

3. Using the cross-level knob, centers the cross-level bubble.

4. Calls "set" after the tube is laid for quadrant.

NUMBER 1 CANNONEER

1. Places the projectile in the loading tray of the power rammer.

2. Rams the projectile with the power rammer.

3. Returns rammer to stowed position.

4. Places the propellant charge in the chamber so that the red ignitor pad is 3 inches inside the rear of the chamber.

5. Closes breech, inserts primer into primer seat, and slides block assembly to the left to position the firing mechanism over the primer.

6. Attaches the lanyard to the eyelet on the firing mechanism lever.

7. At the command of the chief of section, fires the howitzer.

8. Swabs and inspects the powder chamber forcing cone and obturator head after each round is fired and calls "bore clear."

NUMBER 2 CANNONEER

1. Fuzes projectile.

2. Sets selective superquick and delay fuzes.

3. Sets all time and proximity fuzes with the proper fuze setter. Removes setter and verifies setting.

NUMBER 3 CANNONEER

1. Inspects and cleans projectiles.

2. Holds projectile upright while number 2 fuzes the projectile and sets the fuze.

3. Carries fuzed projectile to the howitzer and places it where it will be convenient for number 1.

NUMBER 4 CANNONEER

1. Assisted by the motor carriage driver, prepares propellant charge.

2. Hands propellant charge to motor carriage driver, and disposes of excess powder increments.

NUMBER 5 CANNONEER

1. If present, acts as section radio telephone operator. He will usually be gone with advance party, helping to prepare next battery location. When he is gone, the CS usually serves as the radio telephone operator.

MOTOR CARRIAGE DRIVER

1. Assists number 4 in preparing the propellant charge.

2. Hands the propellant charge to number 1 so that he can grasp the base of the charge with his right hand.

SECTION VEHICLE DRIVER

1. Does tasks as directed by the chief of section.

TABLE 3

LIST OF TASKS PERFORMED BY CREW DURING THE PROCESS OF MARCH ORDERING A HOWITZER

CHIEF OF SECTION

1. Gives command to march order.

2. Inspects chamber to insure that howitzer is not loaded.

3. Supervises the work of the section as they prepare the ammunition for travel.

4. Directs driver in extracting and stowing spades.

5. Verifies that the howitzer is prepared for traveling and takes his post.

6. Reports to the executive officer that his section is in order or reports any defect that the section cannot remedy without delay.

GUNNER

1. Sets azimuth counter to 3,200 mils and closes window. Sets gunner's aid counter to zero. Covers bubbles on the telescope mount.

2. Removes the panoramic telescope from its mount and replaces it in its case.

3. Assists the driver in engaging howitzer travel lock. Places cab power switch in the off position. Locks cab traverse lock.

4. Steps on left and right release pedals respectively, after the driver has backed against spades. Makes sure pedal latch engages pin. Closes left cab door after receiving and stowing the collimator.

5. Verifies that all section equipment is present and secure, and takes his post.

ASSISTANT GUNNER

1. Sets elevation and correction counters to zero. Covers bubbles on the elevation quadrant.

2. Closes right cab door.

3. Takes post.

NUMBER 1 CANNONEER

1. Closes the breechblock after the chief of section has inspected the chamber, and secures the power rammer.

2. Secures sponge, burlap, and cleaning materials and replaces unused primers in travel compartments. Replaces vent and primer seat cleaning tools.

3. Assisted by number 3, lifts the left spade into the travel position.

4. Closes rear cab doors.

5. Takes his post, closing rear hull door.

NUMBER 2 CANNONEER

1. Replaces fuzes in containers and places them in the howitzer compartment.

2. Returns fuze wrenches and setters to their travel chest and replaces ammunition in the howitzer compartment.

3. Assisted by number 4, lifts the right spade into the travel position. Replaces right spade strut safety pin.

4. Takes post.

NUMBER 3 CANNONEER

1. Insures that projectiles are ready for loading, that all fuzes are removed, and that the supplementary charges, lifting plugs, and grommets are replaced.

2. Assists number 1 in lifting the left spade into the travel position.

3. Takes post.

NUMBER 4 CANNONEER

1. Recovers collimator, prepares it for traveling, and passes it to the gunner for storage.

2. Assists number 2 in lifting the right spade into travel position.

3. Takes post.

NUMBER 5 CANNONEER (IF AVAILABLE)

1. Recovers and disassembles aiming posts and hands them to the motor carriage driver for storage.

2. Secures communications equipment.

3. Replaces muzzle plug and cover.

4. Takes post.

MOTOR CARRIAGE DRIVER

1. Disassembles and secures rammer staff sections. Secures aiming posts and pioneer tools.

2. Lifts howitzer travel lock to the vertical position and, assisted by the gunner, locks the tube in the travel position.

3. Closes direct fire telescope window, and closes and secures ballistic cover.

4. Starts engine and backs against spades as directed by the chief of section. To extract spades, drives vehicle forward as directed by the chief of section.

SECTION VEHICLE DRIVER

1. Does tasks as directed by the chief of section.

APPENDIX B

TASK LIBRARY

Emplacement

```
002        800  2.0  2.8  3.0          1
   DIRECTS MD IN BACKING ON TO SPADES
004  800        3.0  4.0  8.0          3
   CHECKS SPADE STRUTS
006  800        0.0  0.0  0.0          4
   DIRECTS MD TO SET BRAKES AND TURN OFF VEHICLE [WHILE MOVING]
008             1.0  2.0  3.0          4
   CHECKS FRONT RECUPERATOR GUIDE PINS
010            11.0 13.0 16.0          3
   CHECKS REAR RECUP PINS, REPLEN GAUGE, + RECOIL SYSTEM
012  126        3.0  5.0 10.0          3
   VERIFIES LAY OF HOWITZER
014             2.0  3.0  5.0          4
   SELECTS ALTERNATIVE AIMING POINT
016  132        2.0  3.0  5.0          4
   INFORMS G OF ALTERNATIVE AIMING POINT
018  134        1.5  2.0  2.5          4
   DIRECTS G + AG TO MEASURE SITE TO CREST
020  136       12.0 16.0 22.0          4
   ESTIMATES DISTANCE TO CREST, REPORTS TO XO + FDC
022  136        1.5  2.0  2.5          4
   DIRECTS G + AG TO BORESIGHT
024        140 40.0 70.0220.0          4
   SUPERVISES BORE SIGHTING
026             5.0  7.0 10.0          4
   VERIFIES BORE SIGHTING
100             2.0  2.5  3.5          3
   OPENS LEFT CAB DOOR
102             1.0  1.5  2.5          3
   MOVES TO DEPRESS LEFT PEDAL LATCH, RETURNS TO STATION
104        602  6.0  8.0 11.0          4
   REMOVES COLLIMATOR, PASSES IT OUT, DIRECTS MAN TO LOCATION
106             1.0  1.5  2.5          3
   SETS CAB POWER SWITCH TO ON, SETS TRAVERSE CONTROL SWITCH
108        806  3.0  6.0 11.0          4
   AS DIRECTED BY MD, G RAISES TUBE
110  806        4.0 13.2 29.0          1
   DEPRESSES TUBE TO MINIMUM ELEVATION
112             1.0  1.2  2.0          3
   SELECTS AG POSITION FOR POWER ELEVATION CONTROL
114  810        1.0  1.5  2.5          3
   G RELEASES LATCHES ON BALLISTIC COVER
116            12.0 16.0 24.0          3
   OBTAINS AND INSTALLS PANORAMIC TELESCOPE
118        708  2.0  3.0  6.0          4
   G + GUN GUIDE DECIDE LOCATIONS FOR AIMING POSTS
120             6.0 15.0 35.0          3
   SETS DEFLECTION TRAVERSES WEAPON TO AIMING POINT
122            12.0 22.3 40.0          1
   TALKS WITH XO, TRAVERSES, ANNOUNCES READY FOR RECHECK [1ST]
124             9.5 13.1 17.0          1
   TALKS WITH XO, TRAVERSES, ANNOUNCES READY FOR RECHECK [2ND]
126             8.0 10.0 15.0          1
```

```
   WHEN XO SAYS O MILS, G REPORTS GUN LAID, RECORDS DEFLECTION
128  606  608 10.5 45.1110.0          1
   DIRECTS MAN IN ALIGNMENT OF COLLIMATOR, RECORDS DEFLECTION
130            2.0  4.0  8.0          4
   RESETS COUNTER TO 3200 MILS
132  708  710 45.0 85.3142.0          1
   DIRECTS MAN IN PLACEMENT OF AIMING POSTS, RECORDS DEFLECTION
134  016      10.0 17.0 37.0          4
   MOVES PANTEL TO ALTERNATIVE AIMING POINT, RECORDS IT
136  018      30.0 60.0180.0          4
   WHEN DIRECTED BY CS, G + AG MEASURE SITE TO CREST
138            6.0 12.0 37.0          4
   RETURNS PANTEL TO COLLIMATOR
140  022  024 40.0 70.0220.0          4
   G BORE SIGHTS AND RETURNS PANTEL TO COLLIMATOR
200            2.0  2.5  3.5          3
   OPENS RIGHT CAB DOOR
202            1.0  1.5  2.5          3
   MOVES TO DEPRESS RIGHT PEDAL LATCH, RETURNS TO STATION
204  112       5.0  7.7 12.0          1
   ELEVATES TUBE TO LOADING ELEVATION
206  018      30.0 60.0180.0          4
   WHEN DIRECTED BY CS, G + AG MEASURE SITE TO CREST
208            3.0  8.0 20.0          4
   RETURNS TUBE TO LOADING ELEVATION
210  022       4.0  7.0 12.0          4
   DEPRESSES TUBE FOR ATTACHMENT OF M-140 DEVICE
212       024 30.0 60.0210.0          4
   AG BORE SIGHTS + CHECKS DIRECT FIRE TELESCOPE
214  718       5.0  7.0 12.0          1
   AG RETURNS TUBE TO LOADING ELEVATION
300            3.5  5.0  6.5          3
   PREPARES LEFT SPADE FOR EMPLACEMENT
302            6.0  7.8 12.0          3
   CHECKS FUNCTION OF FIRING MECHANISMS
304           21.0 32.0 41.0          3
   INSPECTS, CLEANS, OPERATES BREECH BLOCK + POWER RAMMER
306           22.0 32.3 42.5          1
   PROCURES + SECURES WATER BUCKET AND SPONGE
308            5.0  8.0 10.0          4
   PROCURES PRIMERS, PLACES THEM IN A CONVENIENT + SAFE LOCATION
400            2.0  3.0  4.0          1
   OPENS REAR HULL DOOR WHILE DISMOUNTING
402            5.5  7.0  8.0          3
   PREPARES RIGHT SPADE FOR EMPLACEMENT
404            8.0 12.0 20.0          4
   GATHERS FUZE SETTERS IN HOWITZER
406  502       9.5 16.5 25.0          4
   ARRANGES FUZE SETTERS AND WRENCHES IN SV
408            5.0  8.0 15.0          4
   OPENS AND ARRANGES FUZE BOXES
500       900  3.5 14.1 25.5          4
   DIRECTS SD INTO POSITION
502  900       3.0  5.0  8.0          4
   OPENS REAR DOOR OF SECTION VEHICLE
504       408  5.0  8.0 15.0          4
   HELPS MAN OPEN + ARRANGE FUZE BOXES
600           11.0 16.5 20.0          1
```

```
   OBTAINS + ASSEMBLES AIMING POSTS
602       104  6.0  8.0 11.0         4
   RECEIVES COLLIMATOR
604            3.0  4.0  6.0         1
   MOVES TO SET COLLIMATOR
606           35.0 45.0 80.0         2
   REMOVES COVER, FOCUSES COLLIMATOR ON G'S SCOPE
608       128 10.5 45.1110.0         1
   ALIGNS COLLIMATOR
610            4.0  6.0 10.0         1
   RETURNS TO SECTION VEHICLE FROM COLLIMATOR
700  800      22.0 49.7 64.0         2
   INSTALLS BATTERY COMMUNICATION SYSTEM
702  110       5.0  8.0 15.0         4
   REMOVES MUZZLE COVER
704            2.0  2.5  4.0         4
   STORES MUZZLE COVER
706  600       1.0  2.0  3.0         4
   OBTAINS AIMING POSTS
708  118       2.0  3.0  6.0         4
   G + GUN GUIDE DECIDE LOCATIONS FOR AIMING POSTS
710       132 65.5112.8177.0         1
   EMPLACES AND ADJUSTS AIMING POSTS
712            8.0 13.8 19.0         1
   AIMING POST SETTER RETURNS TO WEAPON
714            2.0  3.0  5.0         4
   OBTAINS M-140 DEVICE
716  210      15.0 20.0 30.0         4
   ATTACHES M-140 DEVICE TO TUBE
718  024      10.0 15.0 25.0         4
   REMOVES M-140 DEVICE
720            5.0  7.0 10.0         4
   STORES M-140 DEVICE
800       002  2.0  2.8  3.0         1
   MD BACKS HOWITZER ONTO SPADES
802  006       4.0  6.0  8.0         2
   MD SETS BRAKES AND TURNS OFF VEHICLE
804            4.0  5.0  6.0         2
   MD EXITS HATCH
806       108  4.5  8.0 14.0         2
   DIRECTS G TO RAISE TUBE, DISENGAGES + STOWS TRAVEL LOCK
808            3.5  4.0  6.0         1
   OPENS + UNLOCKS DIRECT FIRE TELESCOPE COVER
810            1.5  2.0  3.0         3
   MOVES TO BALLISTIC COVER, SIGNALS G
812  114       9.0 10.5 14.0         3
   LIFTS + LOCKS BALLISTIC COVER
814            4.0  7.0 10.0         4
   MD STOWS INSTRUMENT PANEL
816            3.5  4.0  4.6         4
   MD SECURES HATCH
900       500  3.5 14.1 25.5         4
   SD MOVES SV INTO POSITION
902            4.0  6.0  8.0         4
   SD TURNS SV OFF, LOCKS BRAKES
```

Fire Mission

```
002            3.0  4.0  7.0          1
   RECEIVES + ANNOUNCES FIRE MISSION
004            3.0  4.0  7.0          1
   ANNOUNCES PROJECTILE
006            3.0  4.0  7.0          1
   ANNOUNCES CHARGE
008            3.0  4.0  7.0          1
   ANNOUNCES FUZE
010            3.0  4.0  7.0          1
   IF FUZE IS TIME, STATES TIME
012            3.0  4.0  7.0          1
   ANNOUNCES DEFLECTION
014            3.0  4.0  7.0          1
   ANNOUNCES QUADRANT
020  104       2.0  2.5  3.0          4
   VERIFIES ADJUSTMENT OF FIRE CONTROL INSTRUMENTS
024  310       2.0  2.5  3.0          4
   INSURES WEAPON IS SAFE TO FIRE, GIVES COMMAND TO FIRE
026            4.0  5.0  8.0          4
   REPORTS PIECE READY, RECEIVES + GIVES COMMAND TO FIRE
100  012       2.5  5.5 10.5          1
   SETS DEFLECTION
102            4.0  9.0 13.0          1
   TRAVERSES TUBE
104  202       2.0  3.0  4.0          1
   AFTER AG CALLS SET, ENSURES BUBBLES ARE LEVEL + CALLS READY
200  014       2.0  4.5 10.5          1
   SETS QUADRANT
202            3.0  8.0 19.5          1
   ELEVATES TUBE TO FIRING POSITION, CALLS SET
300  502       3.0  7.1 15.0          1
   RECEIVES PROJECTILE + MOVES TO LOAD POSITION
302  202       6.0  9.0 11.0          1
   LOADS PROJECTILE + SETS RAMMER
304  700       1.0  1.5  2.0          1
   RECEIVES CHARGE AND MOVES TO LOAD POSITION
306            2.0  4.7  7.0          1
   LOADS PROPELLANT CHARGE + SETS FIRING MECHANISM
308            3.0  6.0 10.5          1
   INSERTS PRIMER + CLOSES BREECH BLOCK
310            2.0  4.5 11.0          1
   ATTACHES LANYARD TO FIRING MECHANISM
312  024       2.0  5.0  9.0          1
   FIRES WEAPON AND CALLS QUADRANT + ROUND, IF NECESSARY
314            5.5  9.2 15.0          1
   SWABS AND CLEANS POWDER CHAMBER
316            3.0  5.0  8.0          1
   INSPECTS BORE + ANNOUNCES BORE CLEAR
318            3.5  3.8  4.1          1
   UNHOOKS LANYARD
400  004      18.0 40.0 95.0          1
   SELECTS + PREPARES PROJECTILE
402  008       3.0  6.3 18.0          1
```

```
   SELECTS PROPER FUZE
404       500  5.5 20.0 42.0          1
   AFFIXES + SETS FUZE
500            5.5 20.0 42.0          1
   HOLDS PROJECTILE WHILE ANOTHER AFFIXES + SETS FUZE
502            3.0  6.3 10.0          1
   CARRIES PROJECTILE TO HOWITZER
504            3.0  3.9  4.5          1
   RETURNS TO REAR OF SECTION VEHICLE [PROJO]
600  006      10.0 13.0 16.0          1
   SELECTS + UNPACKS CHARGE
602            3.0 15.0 25.0          4
   CUTS PROPER CHARGE
604            2.5  3.0  4.0          4
   HANDS CHARGE TO MOTOR DRIVER
606            6.0  7.5 10.0          4
   CARRIES EXCESS POWDER TO POWDER DUMP
608  312       6.0  7.5 10.0          4
   RETURNS FROM POWDER DUMP TO SECTION VEHICLE
800  604       3.0  4.3  7.5          1
   RECEIVES CHARGE, MOVES TO HOWITZER, PASSES CHARGE IN
802            3.0  3.9  4.5          1
   RETURNS TO REAR OF SECTION VEHICLE [CHARGE]
```

March Order

```
002             2.0  3.0  5.0         4
 RECEIVES MARCH ORDER, GIVES COMMAND TO MARCH ORDER
004        816  5.0 10.0 19.0         1
   DIRECTS MD TO START HOWITZER AND MOVE BACKWARDS
006  718        2.0  3.5  4.5         1
   DIRECTS MD TO PULL FORWARD AND STOP
008             2.0  3.0  5.0         4
   DIRECTS SD TO START SECTION VEHICLE
010             2.0  4.0  8.0         4
   CHECKS SPADES FOR SECURITY
012  410       10.0 15.0 25.0         4
   DIRECTS CREW TO MOUNT UP, MAKES CHECKS, SIGNALS XO
014             7.0  8.8 11.0         1
   UNLOCKS CUPOLA + ENTERS
100  002        4.0  7.0 12.0         4
   PREPARES TELESCOPE MOUNT FOR TRAVEL
102            13.0 16.0 22.0         5
   STORES PANORAMIC TELESCOPE FOR TRAVEL
104             1.0  1.5  2.0         4
   RETURNS ELEVATION CONTROL TO GUNNER
106  502        3.0  6.0  9.0         1
   ELEVATES TUBE TO PREPARE FOR TRAVEL
108        302 15.0 25.0 35.0         4
   TRAVERSES GUN AS DIRECTED BY MD
110        604  1.5  3.3  6.0         1
   LOWERS TUBE AS DIRECTED BY MD
112             3.0  4.5  7.0         3
   CAB POWER TO OFF,LOCKS CAB TRAVERSE,SPADES CAN BE STORED
114  816  206   1.5  2.0  4.0         4
   DEPRESSES LEFT PEDAL AND ADVISES MD SPADE IS UNLOCKED
116  504        7.0  9.0 12.0         4
   RECEIVES COLLIMATOR AND STORES IT
118             2.0  3.5  6.0         3
   CLOSES LEFT CAB DOOR
200  002        2.5  4.8  7.0         1
   LOWERS TUBE TO MINIMUM ELEVATION
202             3.0  5.0 10.0         4
   PREPARES ELEVATION QUADRANT FOR TRAVEL
204  408        2.0  3.5  6.0         3
   CLOSES RIGHT CAB DOOR
206  716  114   1.5  2.0  4.0         4
   DEPRESSES RIGHT PEDAL AND ADVISES MD SPADE IS UNLOCKED
300  002        3.0  4.0  7.0         4
   CLOSES BREECH BLOCK
302             8.0 10.0 14.0         4
   SECURES THE POWER RAMMER
304            12.0 18.0 26.0         4
   SECURES SPONGE, BURLAP, + CLEANING MATERIALS
306             4.0  6.0 10.0         4
   PLACES UNUSED PRIMERS IN TRAVEL COMPARTMENTS
308  820  410   3.0  9.0 15.0         1
   LIFTS + LOCKS LEFT SPADE
310  012        3.0  4.5  7.0         2
```

```
   ENTERS HOWITZER, SECURES REAR DOOR IN POSITION
400  002       6.0 10.0 16.0         4
   GATHERS FUZE SETTERS
402           12.0 16.0 22.0         4
   STOWS FUZE SETTERS IN HOWITZER
404            6.0  8.0 11.0         4
   STOWS UNUSED FUZES IN CONTAINERS
406            4.0  6.0 10.0         4
   STORES FUZE CONTAINERS IN HOWITZER
408            1.5  2.0  3.0         4
   PUSHES RIGHT CAB DOOR SHUT FOR AG
410  820  308  3.0  9.0 15.0         1
   LIFTS AND LOCKS RIGHT SPADE
500  002       2.5  3.5  6.0         4
   OBTAINS MUZZLE COVER
502  200      13.0 20.0 30.0         2
   INSTALLS MUZZLE COVER
504           46.0 58.6 70.0         1
   MOVES TO COLLIMATOR, PUTS COVER ON IT, TAKES IT TO G
600  002      49.0 56.2 65.0         1
   MOVES TO GET AIMING POSTS, STORES THEM IN HOWITZER
602            8.0 12.0 20.0         4
   DISCONNECTS COMMO LINES FROM TERMINALS, STORES PHONE
800            1.5  2.3  3.0         1
   LIFTS GUN TRAVEL LOCK
802  106  108 15.0 25.0 35.0         4
   MD DIRECTS G TO TRAVERSE GUN
804       110  1.5  3.3  6.0         1
   MD GIVES INSTRUCTIONS FOR GUN TO BE LOWERED
806            3.5  5.0  8.0         4
   LOCKS TUBE IN TRAVEL LOCK POSITION
808  102       8.0  8.5 12.0         4
   MOVES TO BALLISTICS SHIELD, LOWERS + LOCKS IT
810            3.5  4.0  6.0         1
   MOVES TO AND CLOSES DIRECT FIRE TELESCOPE
812            3.0  5.0  8.0         4
   MD OPENS DRIVER'S HATCH, ENTERS, POSITIONS HIMSELF
814            4.0  8.0 10.0         4
   MD INSTALLS INSTRUMENT PANEL OUTSIDE OF HATCH
816       004  5.0 10.0 19.0         1
   AS DIRECTED BY CS, STARTS HOWITZER + MOVES BACKWARD
818  114       2.0  4.0  9.0         4
   MD ADVISES CS THAT SPADES ARE UNLOCKED
820  006       2.0  3.5  4.5         1
   AS DIRECTED BY CS, MD DRIVES FORWARD + STOPS
900  002      10.0 15.0 20.0         1
   MOVES TO DRIVER STATION OF SECTION VEHICLE
902  008       6.0  8.0 12.0         4
   SD STARTS SECTION VEHICLE + UNLOCKS BRAKES
```

Locomotion

```
1000  102       2.5  3.5  5.0
    EXITS BACK OF HOWITZER (AFTER REAR DOOR IS OPENED)
1002            2.5  3.5  5.0
    EXITS BACK OF HOWITZER (REAR HULL DOOR IS OPEN)
1004            1.5  2.0  3.5
    EXITS SV FROM OUTSIDE FRONT SEAT
1006            2.5  3.5  6.0
    EXITS SV FROM 50 CAL POSITION
1008            2.0  3.0  4.5
    EXITS BACK OF SV
1010  910       3.5  4.5  6.0       5
    ENTERS BACK OF HOWITZER, MOVES TO POSITION
1012            2.5  3.5  5.0
    ENTERS BACK OF SV
1014            3.5  4.5  7.0
    ENTERS FRONT OF SV, MANS 50 CAL
1016  910       2.0  2.5  4.0       5
    ENTERS SV TO OUTSIDE FRONT SEAT
1018            2.0  3.5  6.0       5
    ASSUMES TRAVEL POSITION IN HOWITZER
1020            3.0  4.3  7.5
    MOVES DISTANCE BETWEEN BACK OF HOWITZER & BACK OF SV
1022            3.5  4.5  8.0
    MOVES DISTANCE BETWEEN BACK OF HOW & A SIDE CAB WINDOW
1024            5.2  6.5 13.0
    MOVES DISTANCE BETWEEN BACK & FRONT OF HOWITZER
1026            7.6  9.5 19.0
    MOVES DISTANCE BETWEEN BACK OF HOWITZER & FRONT OF TUBE
1028            5.2  6.5 13.0
    MOVES DIST BETWEEN BACK OF SV & A SIDE CAB WINDOW OF HOW
1030            7.1  9.0 18.0
    MOVES DISTANCE BETWEEN BACK OF SV & FRONT OF HOWITZER
1032            9.8 12.3 24.5
    MOVES DISTANCE BETWEEN BACK OF SV & FRONT OF TUBE
1034            8.0 10.0 20.0
    MOVES DIST BETWEEN FRONT OF SV & A SIDE CAB WINDOW OF HOW
1035            6.0  8.0 10.5       4
    MOVES DISTANCE BETWEEN REAR OF HOW & FRONT OF SV
1036           10.0 12.5 25.0
    MOVES DISTANCE BETWEEN FRONT OF SV & FRONT OF HOWITZER
1038           12.6 15.8 31.5
    MOVES DISTANCE BETWEEN FRONT OF SV & FRONT OF TUBE
1040            3.2  4.0  8.0
    MOVES DISTANCE BETWEEN BACK & FRONT OF SV
1041            6.9  8.6 17.3
    MOVES DISTANCE BETWEEN BACK OF HOWITZER AND FRONT OF SV
1042
    MOVES DISTANCE BETWEEN FRONT & BACK OF HOWITZER (INSIDE)
1043            1.5  2.5  4.0       5
    MOVES SHORT DISTANCE
1044            2.5  3.0  5.0
    MOUNTS FRONT OF HOWITZER, MOVES TO TRAVELING LOCK
1046            2.5  3.0  5.0
```

```
     MOUNTS FRONT OF HOWITZER, MOVES TO RECUPERATOR GUIDE PINS
1048              7.0 10.0 13.0
    *MOUNTS FRONT OF HOWITZER, MOVES TO COMMAND CUPOLA
```

DISTRIBUTION

1 US ARMY WESTERN COMMAND ATTN: APPE
1 DEPARTMENT OF THE NAVY TRAINING ANALYSIS AND EVALUATION GROUP
1 HQDA ATTN: DAAG-ED
1 HQ, TCATA ATTN: ATCAT-OP-Q
2 HQDA RESEARCH AND STUDIES OFC
1 MILITARY OCCUPATIONAL DEVELOPMENT DIV DAPC-MSP-O, RM 852C HOFFMAN BLDG 1
4 OASD (MRA AND L)
1 HQ TCATA TECHNICAL LIBRARY
1 HQDA ODCSPER
1 HQDA ATTN: DAMI-ISI
1 USA AVIATION SYSTEMS COMD ATTN: DRSAV-ZDR
1 USA CORADCOM ATTN: AMSEL-PA-RH
1 USA ARRADCOM ATTN: ATFE-LO-AC
1 HEADQUARTERS US MARINE CORPS ATTN: CODE MTMT
1 HEADQUARTERS, US MARINE CORPS ATTN: CODE MPI-20
2 US ARMY EUROPE AND SEVENTH ARMY
1 1ST INFANTRY DIVISION AND FT. RILEY ATTN: AFZN-DPT-T
1 USA INTELLIGENCE AND SECURITY COMMAND ATTN: IAOPS-TNG-T
2 HQ TRADOC TECHNICAL LIBRARY
1 NAVAL TRAINING EQUIPMENT CEN ATTN: TECHNICAL LIBRARY
1 MILITARY OCCUPATIONAL DEVELOPMENT DIRECTORATE ATTN: ATZI-NCR-MS-M, RM 3N33 HOFFMAN BLDG II
1 DATA ANALYSIS DIVISION ATTN: ATZI-NCR-MD, HOFFMAN BLDG II
1 USA MILPERCEN ATTN: DAPC-POO-T
1 8TH INFANTRY DIVISION
1 HQDA ARMY FORCE MODERNIZATION COORDINATION OFFICE
1 HQDA ATTN: DASG-PTB
1 NAVAL AIR SYSTEM COMMAND /
1 123D USARCOM RESERVE CENTER
1 US ARMY SOLDIER SUPPORT CENTER /
1 USA FORCES COMMAND AFLG - DEPUTY CHIEF OF STAFF FOR LOGISTICS
1 DIRECTORATE OF TRAINING ATTN: ATZQ-T
1 DIRECTORATE OF COMBAT DEVELOPMENTS ATTN: ATZQ-D
1 HQDARCOM MARINE CORPS LIAISON OFC
1 DEPARTMENT OF THE ARMY US ARMY INTELLIGENCE + SECURITY COMMAND
1 USA MISSILE COMMAND ATTN: DRSMI-NTN
1 US ARMY CECOM ATTN: DRSEL-ATDD
1 USA FORCES COMMAND
1 PM TRADE /
1 US MILITARY DISTRICT OF WASHINGTON OFC OF EQUAL OPPORTUNITY
1 NAVAL CIVILIAN PERSONNEL COMD SOUTHERN FLD DIV
22 ARI LIAISON OFFICE
1 7TH ARMY TRAINING COMMAND
1 HQDA, DCSOPS UNIT TRAINING
1 HQDA, DCSOPS TRAINING DIRECTORATE
1 HQDA, DCSLOG MAINTENANCE MANAGEMENT
1 HQDA, OCS STUDY OFFICE
1 U.S. NAVY TRAINING ANALYSIS EVALUATION GROUP
1 USACDEC ATTN: ATEC-EX-E HUMAN FACTORS
1 ATTN: SM-ALC/DPCR
1 OASA (RDA) DEPUTY FOR SCIENCE AND TECHNOLOGY
1 OFC OF NAVAL RESEARCH /
1 AFHRL/LRT
1 AFHRL/LRLG
1 AIR FORCE HUMAN RESOURCES LAB ATTN: AFHRL/TSR
1 AFAMRL/BB
1 NAVY PERSONNEL R AND D CENTER DIRECTOR OF PROGRAMS
1 NAVY PERSONNEL R AND D CENTER /
2 OFC OF NAVAL RESEARCH PERSONNEL AND TRAINING RESEARCH PROGRAMS
1 NAVAL PERSONNEL R + D CENTER /
1 OFC OF NAVAL RESEARCH PROJECT OFFICER, ENVIRONMENTAL PHYSIOLOGY
1 OFC OF NAVAL RSCH ORGANIZATIONAL EFFECTIVENESS PRO.

1 NAVAL AEROSPACE MEDICAL RSCH LAB AIRBORNE RANGER RESEARCH
1 NAVAL AEROSPACE MEDICAL RSCH LAB AEROSPACE PSYCHOLOGY DEPARTMENT
1 USA TRADOC SYSTEMS ANALYSIS ACTIVITY ATTN: ATAA-TCA
1 HEADQUARTERS, COAST GUARD CHIEF, PSYCHOLOGICAL RSCH BR
1 USA RESEARCH AND TECHNOLOGY LAB /
1 USA ENGINEER TOPOGRAPHIC LABS ATTN: ETL-GSL
1 USA MOBILITY EQUIPMENT R AND D COMD ATTN: DRDME-TQ (SCHOOL)
1 FT. BELVOIR, VA 22060
1 ATTN: ATTG-ATB-TA
1 USA HUMAN ENGINEERING LAB
1 USA MATERIEL SYSTEMS ANALYSIS ACTIVITY ATTN: DRXSY-C
1 USA ARCTIC TEST CEN ATTN: AMSTE-PL-TS
1 USA COLD REGIONS TEST CEN ATTN: STECR-OP
1 USA CONCEPTS ANALYSIS AGCY ATTN: CSCA-RQP
1 USA CONCEPTS ANALYSIS AGCY ATTN: CSCA-JF
1 USACACDA ATTN: ATZL-CAC-IC
1 USACACDA ATTN: ATZL-CAC-IM
1 USACAC ATTN: ATZL-CAC-IA
1 USACACDA ATTN: ATZL-CAC-A
1 USA RSCH DEVEL + STANDARDIZA GP, U.K.
1 USA RESEARCH AND DEVELOPMENT LABS CHIEF, BEHAV SCIENCES DIV, FOOD SCI LAB
1 TRAJANA ATTN: SAJS-OR
1 NAVAL AIR SYSTEMS COMMAND ATTN: AIR-5313
1 USACDEC TECHNICAL INFORMATION CENTER
1 USAARL LIBRARY
1 USA TRADOC SYSTEMS ANALYSIS ACTIVITY ATTN: ATAA-SL (TECH LIBRARY)
1 UNIFORMED SERVICES UNIT OF THE HEALTH SCI DEPARTMENT OF PSYCHIATRY
1 USA COMPUTER SYSTEMS COMMAND ATTN: COMMAND TECHNICAL LIBRARY H-9
1 GRONINGER LIBRARY ATTN: ATZF-RS-L BLDG 1313
1 CENTER FOR NAVAL ANALYSIS
1 NAVAL HEALTH RSCH CEN LIBRARY
1 NAVAL PERSONNEL R AND D CEN LIBRARY ATTN: CODE P106
1 AIR FORCE HUMAN RESOURCES LAB ATTN: AFHRL/OTS
1 HQ, FT. HUACHUCA ATTN: TECH REF DIV
1 USA ACADEMY OF HEALTH SCIENCES STIMSON LIBRARY (DOCUMENTS)
1 SCHOOL OF SYSTEMS AND LOGISTICS /
1 DEPARTMENT OF THE NAVY TRAINING ANALYSIS AND EVALUATION GP
1 USMA DEPT OF BEHAVIORAL SCI AND LEADERSHIP
1 USA COMMAND AND GENERAL STAFF COLLEGE ATTN: LIBRARY
1 USA TRANSPORTATION SCHOOL USA TRANSP TECH INFO AND RSCH CEN
1 USA ADMINCEN TECHNICAL RESEARCH BRANCH LIBRARY
1 USA FIELD ARTY BD /
1 INSTITUTE FOR DEFENSE ANALYSES
1 USA TRAINING SUPPORT CENTER ATTN: ATIC-DST-PA
1 AFHRL TECHNOLOGY OFC (H)
1 USA MOBILITY EQUIPMENT R AND D COMMAND ATTN: DRDME-ZG
1 DA US ARMY RETRAINING BDE RESEARCH + EVALUATION DIVISION
1 US MILITARY ACADEMY DEPT. OF HISTORY, BLDG 601
1 MARINE CORPS INSTITUTE
1 NAVAL SAFETY CENTER /
1 GALLAUDET COLLEGE LEARNING CENTER
1 USAAVNC AND FT. RUCKER ATTN: ATZQ-ES
1 US ARMY AVN TNG LIBRARY ATTN: CHIEF LIBRARIAN
1 USA AIR DEFENSE SCHOOL ATTN: ATSA-DT
1 USAAVNC AT .: ATZQ-D
1 US MILITARY ACADEMY DIRECTOR OF INSTITUTIONAL RSCH
1 USA AIR DEFENSE SCHOOL ATTN: ATSA-CD-MS
1 USAADS-LIBRARY-DOCUMENTS
1 USA AIR DEFENSE BOARD ATTN: FILES REPOSITORY
1 USA INFANTRY BOARD ATTN: ATZB-IB-AE
1 USA INTELLIGENCE CEN AND SCH ATTN: ATSI-DT-SFL
1 USA ORDNANCE CEN AND SCH ATTN: ATSL-TD-TAC

1 USA ARMOR SCHOOL ATTN: ATZK-TD
1 USA ARMOR CENTER DIRECTORATE OF COMBAT DEVELOPMENTS
1 NAVAL POSTGRADUATE SCH ATTN: DUDLEY KNOX LIBRARY (CODE 1424)
1 USA TRANSPORTATION SCHOOL DEPUTY ASST. COMMANDANT EDUCA. TECHNOLOGY
1 USA SIGNAL SCHOOL AND FT. GORDON ATTN: ATZH-ET
1 USA QUARTERMASTER SCH ATTN: ATSM-TNG-TM-ET
1 USA MILITARY POLICE SCHOOL ATTN: LIBRARY
1 USA ARMOR CENTER + FT. KNOX OFFICE OF ARMOR FORCE MGT + STANDARDIZATION
1 CHIEF OF NAVAL EDUCATION AND TNG /
1 USA SIGNAL SCHOOL + FT. GORDON EDUCATIONAL TECHNOLOGY DIVISION
1 HQ AIC/XPTD TRAINING SYSTEMS DEVELOPMENT
1 USA INSTITUTE FOR MILITARY ASSISTANCE ATTN: ATSU-TD-TA
5 USA INTELLIGENCE CEN AND SCH ATTN: ATSI-ERM
1 US ARMY ARMOR CENTER ATTN: ATZK-TD-PMO
1 USA AIR DEFENSE CENTER, FT. BLISS ATTN: ATZC-DIM
1 USA QUARTERMASTER SCHOOL DIRECTORATE OF TRAINING DEVELOPMENTS
1 US COAST GUARD ACADEMY /
1 USA TRANSPORTATION SCHOOL DIRECTORATE OF TRAINING + DOCTRINE
1 USA INFANTRY SCHOOL LIBRARY /
1 USA INFANTRY SCHOOL ATTN: ATSH-I-V
1 US ARMY INFANTRY SCHOOL ATTN: ATSH-CD
1 USA INFANTRY SCHOOL ATTN: ATSH-DOT-LRD
1 USA INFANTRY SCHOOL ATTN: ATSH-EV
1 USA MP + CHEM SCH/TNG CEN + FT. MCCLELLAN ATTN: ATZN-PTS
1 USA MP + CHEM SCH/TNG CEN + FT. MCCLELLAN DIR. COMBAT DEVELOPMENT
1 USA MP + CHEM SCH/TNG CEN + FT. MCCLELLAN DIR. TRAINING DEVELOPMENT
1 USA MP + CHEM SCH/TNG CEN + FT. MCCLELLAN ATTN: ATZN-MP-ACE
1 USA INSTITUTE OF ADMINISTRATION ATTN: RESIDENT TRAINING MANAGEMENT
1 USA FIELD ARTILLERY SCHOOL MORRIS SWETT LIBRARY
1 USA INSTITUTE OF ADMINISTRATION ACADEMIC LIBRARY
1 USA WAR COLLEGE ATTN: LIBRARY
1 USA ENGINEER SCHOOL LIBRARY AND LEARNING RESOURCES CENTER
1 USA ARMOR SCHOOL (USARMS) ATTN: LIBRARY
1 US COAST GUARD ACADEMY LIBRARY
1 USA TRANSPORTATION SCHOOL TRANSPORTATION SCHOOL LIBRARY
1 ORGANIZATIONAL EFFECTIVENESS CEN + SCH ATTN: LIBRARIAN
1 US ARMY INTELLIGENCE CENTER + SCHOOL ATTN: ATSI-TP
1 US ARMY INTELLIGENCE CENTER + SCHOOL ATTN: ATSI-RM-M
1 US ARMY INTELLIGENCE CENTER + SCHOOL ATTN: ATSI-ES
1 USA FIELD ARTILLERY SCHOOL DIRECTORATE OF COURSE DEV + TRAINING
1 DEPARTMENT OF THE AIR FORCE AIR UNIVERSITY LIBRARY (ATC)
1 HQ TRADOC TRAINING DEVELOPMENT INSTITUTE
2 BRITISH EMBASSY BRITISH DEFENCE STAFF
2 CANADIAN JOINT STAFF
1 COLS (W) LIBRARY
1 FRENCH ARMY ATTACHE
1 AUSTRIAN EMBASSY DEFENSE, MILITARY AND AIR ATTACHE
3 CANADIAN DEFENCE LIAISON STAFF ATTN: COUNSELLOR, DEFENCE R AND D
1 ROYAL NETHERLANDS EMBASSY MILITARY ATTACHE
1 CANADIAN FORCES BASE CORNWALLIS ATTN: PERSONNEL SELECTION
2 CANADIAN FORCES PERSONNEL APPL RSCH UNIT
1 ARMY PERSONNEL RESEARCH ESTABLISHMENT
6 LIBRARY OF CONGRESS EXCHANGE AND GIFT DIV
1 DEFENSE TECHNICAL INFORMATION CEN ATTN: DTIC-DDA-2
140 LIBRARY OF CONGRESS UNIT DOCUMENTS EXPEDITING PROJECT
1 US GOVERNMENT PRINTING OFC LIBRARY, PUBLIC DOCUMENTS DEPARTMENT
1 US GOVERNMENT PRINTING OFC LIBRARY AND STATUTORY, LIB DIV (SLL)
1 THE ARMY LIBRARY ATTN: ARMY STUDIES SEC
3 / /
1 / /